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# *Short term validated geochemical model of $CO_2$ sequestration*

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In this work we present a new approach to model the effects of $CO_2$ sequestration that has been tested in the Weyburn test site. The Weyburn oil-pull is recovered from Midale Beds (at 1300-1500 m depth). This formation consists of Mississippian shallow marine evaporitic carbonates that can be divided into two units: i) the dolomitic "Marly" and ii) the underlying calcitic "Vuggy", sealed by an anhydrite cap-rock. Presently, about 3 billions mc of supercritical $CO_2$ have been injected into the "Phase A1" injection area. The aim of our model is to reconstruct i) the chemical composition of the reservoir; ii) the geochemical evolution of the reservoir with time as $CO_2$ is injected and ii) the boundary conditions. The geochemical modeling has been performed by using the code PRHEEQC (V2.11) software package. The "primitive brine" composition was calculated on the basis of the chemical equilibrium among the various phases, assuming reservoir equilibrium conditions for the mineral assemblage with respect to a Na-Cl (Cl/Na=1.2) water, at T of 62 °C and P of 150 bars *via* thermodynamic corrections to the code database. A comparison between the chemical composition of the "primitive brine" and that analytically determined on water samples collected before the $CO_2$ injection shows an agreement within 10 %. Furthermore, we computed the kinetic evolution of the reservoir by considering the local equilibrium and the kinetically controlled reactions taking into account the $CO_2$ injected during four years of monitoring. The calculated chemical composition after the $CO_2$ injection is consistent with the analytical data of samples collected in 2004, with the exception of calcium and magnesium contents. The results of the Inverse Modeling Simulation (IMS) suggest that the measured Ca and Mg contents are higher than those calculated from the solubility of calcite and dolomite, likely due to the complexation effect of carboxilic acid.

The results of the application of the kinetic model lasting 100 years indicate that dissolution of K-feldspar and kaolinite and precipitation of chalcedony affect the Marly and Vuggy units. Furthermore, calcite tends to be dissolved as $CO_2$ solubilises in the reservoir, whereas dolomite dissolution can be considered negligible. Dawsonite precipitates as secondary mineral. The $CO_2$ content from solubility trapping (short/medium-term sequestration) calculation is ~0.8 mol/L.